Ephemeris of the Satellites of Mars, 1896–97. By A. Marth.

Professor Hermann Struve has been good enough to communicate, in advance of the publication of his observations of the satellites, the results which he has deduced for the longitudes l and mean motions n of the satellites, and also for the semi-axes a of their orbits. His values are ($l = w + \mathrm{N}$, w being the orbital longitude reckoned from N, the ascending node of the orbit on the plane parallel to the Earth's equator) for 1894 October 0·0 Greenwich :

Phobos	$l_1 = 296^\circ 20$	$n_1 = 1128^\circ 84394$	$a_1 = 12''\cdot948$ at dist. 1.
Deimos	$l_2 = 186^\circ 38$	$n_2 = 285^\circ 16194$	$a_2 = 32''\cdot321$

Adopting these values, and referring the positions of the satellites to the assumed plane of the planet's equator, the data of the "Ephemeris for physical observations of *Mars*" become available, and the areocentric longitudes $l - \mathrm{L}$ of the satellites reckoned from the point of their orbits in opposition to the Earth, and the semidiameters a b of the apparent orbits, will be :

		Phobos.			*Deimos.*		
Greenwich Noon. 1896.	P+90°	a_1	b_1	$l_1 - \mathrm{L}$	a_2	b_2	$l_2 - \mathrm{L}$
	°	″	″	°	″	″	°
Sept. 9	56·58	13·49	−0·68	329·48	33·74	−1·71	250·11
11	56·92	13·66	0·60	66·33	34·17	1·49	99·54
13	57·27	13·83	0·51	163·21	34·60	1·27	308·99
15	57·62	14·01	0·42	260·11	35·05	1·05	158·46
17	57·97	14·19	0·33	357·03	35·51	0·83	7·96
19	58·32	14·38	0·25	93·96	35·99	0·62	217·48
21	58·66	14·58	0·16	190·92	36·48	0·40	67·02
23	59·00	14·78	−0·08	287·90	36·98	−0·19	276·58
25	59·34	14·99	+0·01	24·91	37·50	+0·02	126·16
27	59·67	15·20	0·09	121·94	38·03	0·23	335·77
29	60·00	15·42	0·17	219·00	38·58	0·43	185·41
Oct. 1	60·32	15·64	0·25	316·09	39·14	0·63	35·07
3	60·62	15·87	0·33	53·20	39·72	0·82	244·76
5	60·92	16·11	0·40	150·34	40·31	1·00	94·48
7	61·20	16·35	+0·47	247·52	40·92	+1·18	304·23
9	61·47	16·60	0·54	344·72	41·54	1·35	154·01
11	61·73	16·86	0·60	81·96	42·18	1·51	3·83
13	61·97	17·12	0·66	179·23	42·83	1·66	213·68

Greenwich Noon. 1896.	P+90°			*Phobos.*		*Deimos.*	
		a_1	b_1	l_1-L	a_2	b_2	l_2-L
	°	″	″	°	″	″	°
Oct. 15	62·19	17·38	0·72	276·54	43·49	1·79	63·57
17	62·39	17·65	0·77	13·89	44·17	1·92	273·50
19	62·58	17·93	+0·81	111·27	44·86	+2·03	123·46
21	62 74	18·21	0·85	208·69	45·56	2·13	333·46
23	62·88	18·50	0·88	306·16	46·28	2·21	183·51
25	63·00	18·79	0·90	43·67	47·00	2·27	33·60
27	63·09	19·08	0·92	141·22	47·73	2·31	243·74
29	63·16	19·37	0·93	238·81	48·46	2·33	353·92
31	63·20	19·66	+0·93	336·45	49·19	+2·32	304·15
Nov. 2	63·21	19·95	0·92	74·14	49·93	2·29	154·43
4	63·20	20·25	0·90	171·88	50·66	2·24	4·76
6	63·15	20·54	0·86	269·67	51·38	2·16	215·14
8	63·08	20·82	0·82	7·51	52·08	2·05	65·57
10	62·98	21·09	0·77	105·40	52·77	1·91	276·05
12	62·85	21·36	+0·70	203·33	53·44	+1·74	126·59
14	62·69	21·61	0·62	301·31	54·08	1·54	337·17
16	62·50	21·85	0·52	39·34	54·68	1·31	187·80
18	62·29	22·08	0·41	137·41	55·24	1·04	38·48
20	62·05	22·29	0·30	235 53	55·76	0·75	249·21
22	61·79	22·47	0·17	333·69	56·23	0·43	99·98
24	61·51	22·64	+0·03	71·89	56·64	+0·08	310·79
26	61·21	22·78	−0·12	170·12	56·98	−0·28	161·64
28	60·89	22·89	0·27	268·38	57·26	0·67	12·53
30	60·57	22·97	0·43	6·67	57·47	1·08	213·45
Dec. 2	60·23	23·02	0·60	104·98	57·59	1·49	74·39
4	59·88	23·04	0·77	203·31	57·64	1·91	285·35
6	59·53	23·02	0·93	301·65	57·60	2·34	136·32
8	59·19	22·97	−1·10	39·99	57·47	−2·76	347·30
10	58·85	22·89	1·26	138·33	57·27	3·16	198·29
12	58·51	22·77	1·42	236·66	56·98	3·55	49·28
14	58·19	22·63	1·57	334·98	56·61	3·92	260·25
16	57·88	22·45	1·71	73·28	56·16	4·26	111·21
18	57·58	22·24	1·83	171·56	55·65	4·58	322·15
20	57·30	22·01	−1·95	269·81	55·07	−4·87	173·06
22	57·04	21·75	2·05	8·02	54·42	5·13	23·94
24	56·79	21·47	2·14	106·19	53·72	5·35	234·79
26	56·57	21·18	2·21	204·33	52·98	5·53	85·60
28	56·37	20·86	2·27	302·42	52·20	5·68	296·38

Greenwich Noon. 1896.	P+90°	a_1	b_1		*Phobos.* l_1-L	a_2	*Deimos.* b_2	l_2-L
	°	″	″		°	″	″	°
Dec. 30	56·19	20·53	2·32		40·47	51·38	5·80	147·11
Jan. 1	56·03	20·19	−2·35		138·47	50·53	−5·88	357·79
3	55·89	19·85	2·37		236·41	49·66	5·93	208·43
5	55·77	19·49	2·38		334·31	48·77	5·95	59·02
7	55·68	19·13	2·38		72·16	47·87	5·94	269·57
9	55·61	18·77	2·36		169·95	46·96	5·90	120·06
11	55·55	18·41	2·33		267·69	46·05	5·84	330·50
13	55·52	18·05	−2·30		5·38	45·15	−5·76	180·90
15	55·50	17·69	2·26		103·02	44·25	5·65	31·25
17	55·51	17·33	2·21		200·61	43·36	5·53	241·55
19	55·53	16·98	2·15		298·16	42·48	5·39	91·80
21	55·57	16·63	2·09		35·66	41·62	5·23	302·02
23	55·62	16·29	2·03		133·12	40·77	5·07	152·19
25	55·69	15·96	−1·96		230·53	39·93	−4·89	2·32
27	55·78	15·63	1·88		327·90	39·12	4·71	212·41
29	55·88	15·31	1·80		65·23	38·32	4·51	62·46
31	56·00	15·00	1·72		162·52	37·54	4·31	272·47
Feb. 2	56·14	14·70	1·64		259·78	36·78	4·11	22·45
4	56·29	14·40	1·56		357·00	36·04	3·90	332·39
6	56·45	14·12	−1·48		94·19	35·32	−3·69	182·30
8	56·63	13·84	1·39		191·34	34·62	3·48	32·18
10	56·83	13·57	1·30		288·46	33·94	3·26	242·03
12	57·04	13·30	1·22		25·56	33·28	3·04	91·85
14	57·27	13·05	1·13		122·62	32·65	2·82	301·65
16	57·51	12·80	1·04		219·66	32·03	2·61	151·42

The differences of successive values of l_1-L vary between 2256°·85 and 2258°·34, and of l_2-L between 569°·43 and 570°·99.

The values of P, a, b, $l-L$ being interpolated directly for the times for which the positions of the satellites are required, the rectangular coordinates x and y of the satellites referred to the axes of the planet's disc, or their position-angles p and apparent distances s are found by means of the formulæ

$$x = s \sin (p-P) = a \sin (l-L)$$
$$y = s \cos (p-P) = b \cos (l-L) + a \cos B \,.\, \sin \gamma \sin (l-\Gamma),$$

where the inclinations γ and nodes Γ of the satellite's orbits referred to the assumed plane of the planet's equator have the following values :—

		γ_1	$O-\Gamma_1$	γ_2	$O-\Gamma_2$	δl_2
		°	°	°	°	°
1896, Sept.	17	0·920	169·8	0·979	231·44	−0·014
Oct.	6	·920	178·6	0·988	231·82	·016
	27	·920	187·3	0·966	232·09	·018
Nov.	16	·920	196·1	1·002	232·31	·020
Dec.	6	0·921	204·8	1·005	232·52	−0·023
	26	·922	213·6	1·007	232·77	·026
1897, Jan.	15	·923	222·3	1·007	233·10	·028
Feb.	4	·924	231·3	1·006	233·53	·029
	24	0·925	239·7	1·005	234·08	−0·029

These values have been derived from H. Struve's statements (*Astron. Nachr.* No. 3302) by means of equations which are analogous to those for *Jupiter's* satellites (*Monthly Notices*, vol. li. p. 513).

$$\gamma_1 \sin (O-\Gamma_1) = \quad + 0°.93 \sin G_1$$
$$\gamma_1 \cos (O-\Gamma_1) = 0°.01 + 0°.93 \cos G_1$$
$$\gamma_2 \sin (O-\Gamma_2) = \quad + 1°.72 \sin G_2 - 0°.016 \sin 2 (O-l_0)$$
$$\gamma_2 \cos (O-\Gamma_2) = 0°.93 + 1°.72 \cos G_2 - 0°.016 \cos 2 (O-l_0)$$
$$\text{in which } G_1 = 227°.6 + 158°.0 \quad (T-1894.80)$$
$$G_2 = 193°.7 + 6°.374 \quad (T-1894.80)$$

and l_0 denotes the planet's mean longitude.

δl_2 is the effect of the Sun's perturbation on the longitude l_2 of *Deimos*.

Greenwich times at which the satellites will be at their greatest elongations (*e* in position P+90° and *w* in position P−90°), the designation in the case of *Phobos* belonging to both given times, so that an elongation on the opposite side occurs at mid-time between them.

	Phobos.		*Deimos.*			*Phobos.*		*Deimos.*	
1896.	h m		h m		1896.	h m		h m	
Sept. 9	14 3	*w*	21 42	16 51 *e*	Sept. 18	16 15	*e*	23 55	13 10 *e*
10	13 1	*w*	20 40	23 12 *e*	19	15 14	*e*	22 53	19 36 *e*
11	15 49	*e*	23 28	14 22 *w*	20	14 12	*e*	21 51	10 46 *w*
12	14 47	*e*	22 27	20 43 *w*	21	13 10	*e*	20 49	17 6 *w*
13	13 45	*e*	21 25	11 53 *e*	22	15 58	*w*	23 37	23 27 *w*
14	12 43	*e*	20 23	18 14 *e*	23	14 56	*w*	22 35	14 37 *e*
15	15 31	*w*	23 11	24 34 *e*	24	13 54	*w*	21 33	20 57 *e*
16	14 30	*w*	22 9	15 45 *w*	25	12 52	*w*	20 31	12 7 *w*
17	13 28	*w*	21 7	22 5 *w*	26	15 40	*e*	23 19	18 27 *w*

		Phobos.			*Deimos.*		
1896.		h	m		h	m	
Sept.	27	14	38	*e*	22	17	24 48 *w*
	28	13	36	*e*	21	15	15 58 *e*
	29	12	34	*e*	20	13	22 18 *e*
	30	15	22	*w*	23	1	13 28 *w*
Oct.	1	14	20	*w*	21	59	19 48 *w*
	2	13	18	*w*	20	57	10 58 *e*
	3	12	16	*w*	19	55	17 17 *e*
	4	15	4	*e*	22	43	23 37 *e*
	5	14	2	*e*	21	41	14 47 *w*
	6	13	0	*e*	20	39	21 7 *w*
	7	15	47	*w*	23	27	12 17 *e*
	8	14	45	*w*	22	25	18 36 *e*
	9	13	43	*w*	21	23	24 56 *e*
	10	12	41	*w*	20	21	16 6 *w*
	11	15	29	*e*	23	8	22 25 *w*
	12	14	27	*e*	22	6	13 35 *e*
	13	13	25	*e*	21	4	19 54 *e*
	14	12	23	*e*	20	2	11 4 *w*
	15	15	10	*w*	22	50	17 23 *w*
	16	14	8	*w*	21	47	23 42 *w*
	17	13	6	*w*	20	45	14 52 *e*
	18	12	4	*w*	19	43	21 11 *e*
	19	14	51	*e*	22	31	12 20 *w*
	20	13	49	*e*	21	29	18 39 *w*
	21	12	47	*e*	20	26	24 58 *w*
	22	11	45	*e*	19	24	16 8 *e*
	23	14	32	*w*	22	12	22 26 *e*
	24	13	30	*w*	21	9	13 36 *w*
	25	12	28	*w*	20	7	19 54 *w*
	26	11	26	*w*	19	5	11 3 *e*
	27	14	13	*e*	21	52	17 22 *e*
	28	13	11	*e*	20	50	23 40 *e*
	29	12	9	*e*	19	48	14 49 *w*
	30	11	6	*e*	18	46	21 7 *w*
	31	13	54	*w*	21	33	12 16 *e*
Nov.	1	12	51	*w*	20	31	18 34 *e*
	2	11	49	*w*	19	28	9 43 *w*
	3	10	47	*w*	18	26	16 1 *w*
	4	13	34	*e*	21	13	22 19 *w*
	5	12	32	*e*	20	11	13 28 *e*
	6	11	29	*e*	19	8	19 46 *e*
	7	10	27	*e*	18	6	10 55 *w*
	8	13	14	*w*	20	53	17 12 *w*
	9	12	12	*w*	19	51	23 29 *w*
	10	11	9	*w*	18	48	14 38 *e*
	11	10	7	*w*	17	46	20 55 *e*
	12	12	54	*e*	20	33	12 4 *w*
	13	11	51	*e*	19	30	18 21 *w*
	14	10	49	*e*	18	28	9 29 *e*
	15	9	46	*e*	17	25	15 46 *e*
	16	12	33	*w*	20	13	22 3 *e*
	17	11	31	*w*	19	10	13 12 *w*
	18	10	28	*w*	18	7	19 28 *w*
	19	9	26	*w*	17	5	10 37 *e*
	20	12	13	*e*	19	52	16 53 *e*
	21	11	10	*e*	18	49	23 10 *e*
	22	10	7	*e*	17	47	14 18 *w*
	23	12	54	*w*	20	34	20 34 *w*
	24	11	52	*w*	19	31	11 42 *e*
	25	10	49	*w*	18	28	17 58 *e*
	26	9	46	*w*	17	26	9 7 *w*
	27	12	33	*e*	20	12	15 23 *w*
	28	11	31	*e*	19	10	21 39 *w*
	29	10	28	*e*	18	7	12 47 *e*
	30	9	25	*e*	17	4	19 3 *e*
Dec.	1	12	12	*w*	19	51	10 11 *w*
	2	11	9	*w*	18	49	16 27 *w*
	3	10	7	*w*	17	46	22 43 *w*
	4	9	4	*w*	16	43	13 51 *e*
	5	11	51	*e*	19	30	20 6 *e*
	6	10	48	*e*	18	27	11 14 *w*
	7	9	46	*e*	17	25	17 20 *w*
	8	8	43	*e*	16	22	8 38 *e*
	9	11	30	*w*	19	9	14 54 *e*
	10	10	27	*w*	18	6	21 10 *e*
	11	9	24	*w*	17	3	12 17 *w*

	Phobos.			*Deimos.*	
1896.	h m		h m	h m	
Dec. 12	8 22	*w*	16 1	18 33	*w*
13	11 8	*e*	18 48	9 41	*e*
14	10 6	*e*	17 45	15 57	*e*
15	9 3	*e*	16 42	22 13	*e*
16	8 0	*e*	15 39	13 21	*w*
17	10 47	*w*	18 26	19 37	*w*
18	9 45	*w*	17 24	10 45	*e*
19	8 42	*w*	16 21	17 1	*e*
20	7 39	*w*	15 18	8 9	*w*
21	10 26	*e*	18 5	14 25	*w*
22	9 24	*e*	17 3	20 41	*w*
23	8 21	*e*	16 0	11 50	*e*
24	7 18	*e*	14 58	18 6	*e*
25	10 5	*w*	17 45	9 14	*w*
26	9 3	*w*	16 42	15 30	*w*
27	8 0	*w*	15 39	6 39	*e*
28	6 58	*w*	14 37	12 55	*e*
29	9 45	*e*	17 24	19 12	*e*
30	8 42	*e*	16 21	10 20	*w*
31	7 40	*e*	15 19	16 37	*w*
1897.					
Jan. 1	6 37	*e*	14 16	7 45	*e*
2	9 24	*w*	17 4	14 2	*e*
3	8 22	*w*	16 1	5 11	*w*
4	7 20	*w*	14 59	11 28	*w*
5	6 17	*w*	13 56	17 45	*w*
6	9 4	*e*	16 44	8 54	*e*
7	8 2	*e*	15 41	15 11	*e*
8	7 0	*e*	14 39	6 19	*w*
9	9 47	*w*	17 26	12 37	*w*
10	8 44	*w*	16 24	18 54	*w*
11	7 42	*w*	15 21	10 3	*e*
12	6 40	*w*	14 19	16 21	*e*

	Phobos.			*Deimos.*	
1897.	h m		h m	h m	
Jan. 13	9 27	*e*	17 6	7 30	*w*
14	8 25	*e*	16 4	13 48	*w*
15	7 23	*e*	15 2	4 57	*e*
16	6 20	*e*	14 0	11 15	*e*
17	9 8	*w*	16 47	17 33	*e*
18	8 5	*w*	15 45	8 42	*w*
19	7 3	*w*	14 43	15 0	*w*
20	6 1	*w*	13 40	6 9	*e*
21	8 49	*e*	16 28	12 27	*e*
22	7 46	*e*	15 26	18 46	*e*
23	6 44	*e*	14 24	9 56	*w*
24	5 42	*e*	13 21	16 15	*w*
25	8 30	*w*	16 9	7 24	*e*
26	7 27	*w*	15 7	13 43	*e*
27	6 25	*w*	14 5	4 51	*w*
28	5 23	*w*	13 3	11 10	*w*
29	8 11	*e*	15 50	17 29	*w*
30	7 9	*e*	14 48	8 38	*e*
31	6 7	*e*	13 46	14 57	*e*
Feb. 1	5 5	*e*	12 44	6 6	*w*
2	7 52	*w*	15 32	12 25	*w*
3	6 50	*w*	14 30	18 45	*w*
4	5 48	*w*	13 28	9 54	*e*
5	8 36	*e*	16 15	16 13	*e*
6	7 34	*e*	15 13	7 23	*w*
7	6 32	*e*	14 11	13 42	*w*
8	5 30	*e*	13 9	4 52	*e*
9	8 18	*w*	15 57	11 11	*e*
10	7 16	*w*	14 55	17 31	*e*
11	6 14	*w*	13 53	8 41	*w*
12	9 2	*e*	16 41	15 1	*w*
13	8 0	*e*	15 39	6 10	*e*
14	6 58	*e*	14 37	12 30	*e*

As it is, perhaps, feasible to secure trustworthy observations of the eclipses of *Deimos* near the beginning and ending of the next cycle of eclipses, I give, not only the Greenwich mean times of the satellite's conjunctions with the centre of the shadow cone, but also the computed semi-durations of the eclipses according to the data adopted in the present ephemeris, it being understood

that these semi-durations are liable to considerable uncertainty, and intended merely for guidance. It is essential that the observed disappearances and reappearances of the satellite should refer to corresponding phases, and it is to be hoped that all the most powerful telescopes will be made to contribute.

1896.	Conj. or Middle of Eclipse. h m	Semi-duration. m	1897.	Middle of Eclipse or Conj. h m	Semi-duration. m
Nov. 6	10 6	...	Jan. 12	10 32	∓ 30
7	16 27	...	13	16 53	29
8	22 48	∓ 10	14	23 14	27
10	5 9	15	16	5 35	26
11	11 30	18	17	11 55	24
12	17 51	21	18	18 16	22
14	0 12	23	20	0 37	20
15	6 33	25	21	6 58	17
16	12 54	27	22	13 18	14
17	19 15	29	23	19 39	∓ 9
19	1 36	30	25	2 0	
20	7 57	∓ 31	26	8 21	

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